

Insect repellent

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An **insect repellent** (also commonly called "bug spray") is a substance applied to skin, clothing, or other surfaces which discourages insects (and arthropods in general) from landing or climbing on that surface. Insect repellents help prevent and control the outbreak of insect-borne (and other arthropod-borne) diseases such as malaria, Lyme disease, dengue fever, bubonic plague, and West Nile fever. Pest animals commonly serving as vectors for disease include insects such as flea, fly, and mosquito; and the arachnid tick.



A mosquito coil

Some insect repellents are insecticides (bug killers), but most simply discourage insects and send them flying or crawling away. Almost any might kill at a massive dose without reprieve, but classification as an insecticide implies death even at lower doses.

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Common insect repellents

- Birch tree bark is traditionally made into tar. Combined with another oil (e.g., fish oil) at 1/2 dilution, it is then applied to the skin for repelling mosquitos^{[2][3][4]}
- DEET (*N,N*-diethyl-*m*-toluamide)
- Essential oil of the lemon eucalyptus (*Corymbia citriodora*) and its active compound p-menthane-3,8-diol (PMD)
- Icaridin, also known as picaridin, Bayrepel, and KBR 3023
- Nepetalactone, also known as "catnip oil"
- Citronella oil^[5]
- Neem oil
- Bog Myrtle (*Myrica Gale*)
- Dimethyl carbate
- Tricyclodecanyl allyl ether, a compound often found in synthetic perfumes.^{[6][7]}
- IR3535 (3-[*N*-Butyl-*N*-acetyl]-aminopropionic acid, ethyl ester)
- Ethylhexanediol, also known as Rutgers 612 or "6-12 repellent," discontinued in the US in 1991 due to evidence of causing developmental defects in animals^[8]
- Dimethyl phthalate, not as common as it once was but still occasionally an active ingredient in commercial insect repellents
- Metofluthrin
- Indalone. Widely used in a "6-2-2" mixture (60% Dimethyl phthalate, 20% Indalone, 20% Ethylhexanediol) during the 1940s and 1950s before the commercial introduction of DEET.
- Permethrin is different in that it is actually a contact insecticide.
- A more recent repellent being currently researched is SS220, which has been shown to provide significantly better protection than DEET.
- Another new and promising group of repellents are the anthranilate-based insect repellents.



Oil Jar in cow horn for mosquito-repelling pitch oil, a by-product of the distillation of wood tar. Carried in a leather strap on a belt. Råneå, Norrbotten, since 1921 in Nordiska museet, Stockholm.^[1]

Repellent effectiveness

Synthetic repellents tend to be more effective and/or longer lasting than "natural" repellents.^{[9][10]} In comparative studies, IR3535 was as effective or better than DEET in protection against mosquitoes.^[11] Other sources (official publications of the associations of German physicians^[12] as well as of German druggists^[13] suggest the contrary and state DEET is still the most efficient substance available and the substance of choice for stays in malaria regions, while IR3535 has little effect. However, some plant-based repellents may provide effective relief as well.^{[9][10][14]} Essential oil repellents can be short-lived in their effectiveness, since essential oils can evaporate completely.



A popular post-WWII Australian brand of insect repellent.

A test of various insect repellents by an independent consumer organization found that repellents containing DEET or picaridin are more effective than repellents with "natural" active ingredients. All the synthetics gave almost 100% repellency for the first 2 hours, where the natural repellent products were most effective for the first 30 to 60 minutes, and required reapplication to be effective over several hours.^[15]

For protection against mosquitos, the U.S. Centers for Disease Control (CDC) issued a statement in May 2008 recommending equally DEET, picaridin, oil of lemon eucalyptus and IR3535 for skin.^[16] Permethrin is recommended for clothing, gear, or bed nets.^[9] In an earlier report, the CDC found oil of lemon eucalyptus to be more effective than other plant-based treatments, with a similar effectiveness to low concentrations of DEET.^[17] However, a 2006 published study found in both cage and field studies that a product containing 40% oil of lemon eucalyptus was just as effective as products containing high concentrations of DEET.^[18] Research has also found that neem oil is mosquito repellent for up to 12 hours.^[14] Citronella oil's mosquito repellency has also been verified by research,^[19] including effectiveness in repelling *Aedes aegypti*,^{[20][21]} but requires reapplication after 30 to 60 minutes.

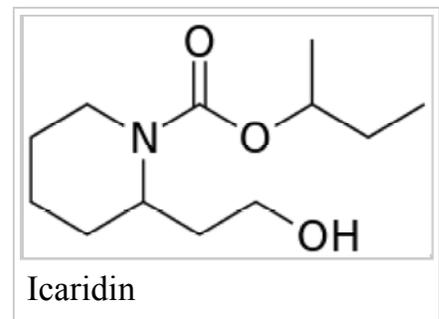
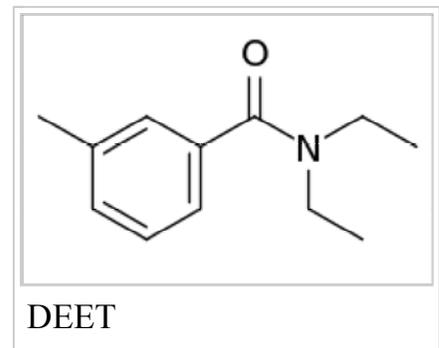
More recently, in 2015, Researchers at New Mexico State University tested 10 commercially available products for their effectiveness at repelling mosquitoes.^[22] On the mosquito *Aedes aegypti*, the vector of Zika virus, only one repellent that did not contain DEET had a strong effect for the duration of the 240 minutes test: a lemon eucalyptus oil repellent. All DEET-containing mosquito repellents were active.

There are also products available based on sound production, particularly ultrasound (inaudibly high frequency sounds) which purport to be insect repellents. However, these electronic devices have been shown to be ineffective based on studies done by the United States Environmental Protection Agency and many universities.^[23]

Repellent safety

Regarding safety with insect repellent use on children and pregnant women:

- Children may be at greater risk for adverse reactions to repellents, in part, because their exposure may be greater.
- Keep repellents out of the reach of children.
- Do not allow children to apply repellents to themselves.
- Use only small amounts of repellent on children.
- Do not apply repellents to the hands of young children because this may result in accidental eye contact or ingestion.
- Try to reduce the use of repellents by dressing children in long sleeves and long trousers tucked into boots or socks whenever possible. Use netting over strollers, playpens, etc.
- As with chemical exposures in general, pregnant women should take care to avoid exposures to repellents when practical, as the fetus may be vulnerable.



Some experts also recommend against applying chemicals such as DEET and sunscreen simultaneously since that would increase DEET penetration. Canadian researcher, Xiaochen Gu, a professor at the University of Manitoba's faculty of

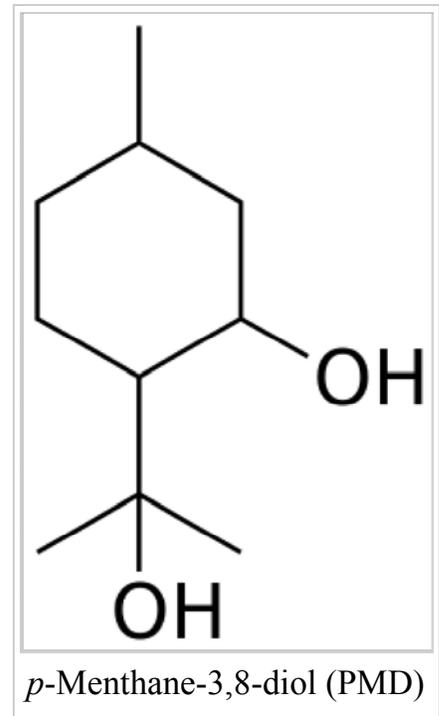
Pharmacy who led a study about mosquitos, advises that DEET should be applied 30 or more minutes later. Gu also recommends insect repellent sprays instead of lotions which are rubbed into the skin "forcing molecules into the skin".^[24]

Regardless of which repellent product used, it is recommended to read the label before use and carefully follow directions.^[25] Usage instructions for repellents vary from country to country. Some insect repellents are not recommended for use on younger children.^[16]

In the DEET Reregistration Eligibility Decision (RED) the United States Environmental Protection Agency (EPA) reported 14 to 46 cases of potential DEET associated seizures, including 4 deaths. The EPA states: "... it does appear that some cases are likely related to DEET toxicity," but observed that with 30% of the US population using DEET, the likely seizure rate is only about one per 100 million users.^[26]

The Pesticide Information Project of Cooperative Extension Offices of Cornell University states that, "Everglades National Park employees having extensive DEET exposure were more likely to have insomnia, mood disturbances and impaired cognitive function than were lesser exposed co-workers".^[27]

The EPA states that citronella oil shows little or no toxicity and has been used as a topical insect repellent for 60 years. However, the EPA also states that citronella may irritate skin and cause dermatitis in certain individuals.^[5] Canadian regulatory authorities concern with citronella based repellents is primarily based on data-gaps in toxicology, not on incidents.^{[28][29]}



Within countries of the European Union, implementation of Regulation 98/8/EC,^[30] commonly referred to as the Biocidal Products Directive, has severely limited the number and type of insect repellents available to European consumers. Only a small number of active ingredients have been supported by manufacturers in submitting dossiers to the EU Authorities.

In general, only formulations containing DEET, icaridin (sold under the trade name Saltidin and formerly known as Bayrepel or KBR3023), IR3535 (3-[N-Butyl-N-acetyl]-aminopropionic acid, ethyl ester) and Citriondiol (p-menthane-3,8-diol) are available. Most "natural" insect repellents such as citronella, neem oil, and herbal extracts are no longer permitted for sale as insect repellents in the EU; this does not preclude them from being sold for other purposes, as long as the label does not indicate they are a biocide (insect repellent).

Insect repellents from natural sources

There are many preparations from naturally occurring sources that have been used as a repellent to certain insects. Some of these act as insecticides while others are only repellent.

- *Achillea alpina* (mosquitos)
- alpha-terpinene (mosquitos)^[31]
- Basil^[32]
 - Sweet Basil (*Ocimum basilicum*)
- *Callicarpa americana* (Beautyberry)^[33]
- Breadfruit (Insect repellent, including mosquitoes^[34])
- Camphor (moths)^[35]
- Carvacrol (mosquitos)^[31]
- Castor oil (*Ricinus communis*) (mosquitos)^[36]
- Catnip oil (*Nepeta* species) (nepetalactone against mosquitos)^[37]
- Cedar oil (mosquitos, moths)^[36]
- Celery extract (*Apium graveolens*) (mosquitos)^[31] In clinical testing an extract of celery was demonstrated to be at least equally effective to 25% DEET,^[38] although the commercial availability of such an extract is not known.



Mosquito repellent made from plants

- Cinnamon^[39] (leaf oil kills mosquito larvae)^[40]
- Citronella oil (repels mosquitos)^[36]
- Oil of cloves (mosquitos)^[36]
- Eucalyptus oil (70%+ eucalyptol), (cineol is a synonym), mosquitos, flies, dust mites^[41])
- Fennel oil (*Foeniculum vulgare*) (mosquitos)^[31]
- Garlic (*Allium sativum*) (Mosquito, rice weevil, wheat flour beetle)^[42]
- Geranium oil (also known as *Pelargonium graveolens*)^{[36][43]}
- Lavender (ineffective alone, but measurable effect in certain repellent mixtures)^{[44][45]}
- Lemon eucalyptus (*Corymbia citriodora*) essential oil and its active ingredient p-menthane-3,8-diol (PMD)
- Lemongrass oil (*Cymbopogon* species) (mosquitos)^[36]
 - East-Indian Lemon Grass (*Cymbopogon flexuosus*)^[46]
- Marigolds (*Tagetes* species)
- Marjoram (Spider mites *Tetranychus urticae* and *Eutetranychus orientalis*)^[47]
- Neem oil (*Azadirachta indica*) (Repels or kills mosquitos, their larvae and a plethora of other insects including those in agriculture)
- Oleic acid, repels bees and ants by simulating the "Smell of death" produced by their decomposing corpses.
- Pennyroyal (*Mentha pulegium*) (mosquitos,^[41] fleas^[48]), but very toxic to pets.^[48]
- Peppermint (*Mentha x piperita*) (mosquitos)^[49]
- Pyrethrum (from *Chrysanthemum* species, particularly *C. cinerariifolium* and *C. coccineum*)
- Rosemary (*Rosmarinus officinalis*)^[47] (mosquitos)^[36]
- Spanish Flag (*Lantana camara*) (against Tea Mosquito Bug, *Helopeltis theivora*)^[50]
- Tea tree oil^[51] from the leaves of *Melaleuca alternifolia*
- Thyme (*Thymus* species) (mosquitos)^[31]
- Yellow Nightshade (*Solanum villosum*), berry juice (against *Stegomyia aegypti* mosquitos)^[52]
- *Andrographis paniculata* extracts (mosquito)^[53]

Inactive substances – carriers

In 2002, the *New England Journal of Medicine*^[54] published an article that found products containing essential oils such as catnip^[55] or geranium oil, when combined with a suitable carrier oil such as soybean, have been found to be effective as natural repellents. This was based on testing done by Johns Hopkins^[56] and Cornell Universities.^[57] Other commercial products offered for household mosquito "control" include small electrical mats, mosquito repellent vapor, DEET-impregnated wrist bands, mosquito fogging, and mosquito coils containing a form of the chemical allethrin. Mosquito-repellent candles containing citronella oil are sold widely in the U.S. These have been used with mixed reports of success and failure.^[58]

Less effective methods

Some old studies suggested that the ingestion of large doses of thiamine could be effective as an oral insect repellent against mosquito bites. However, there is now conclusive evidence that thiamin has no efficacy against mosquito bites.^{[59][60][61][62]} Some claim that plants like wormwood or sagewort, lemon balm, lemon grass, lemon thyme and the mosquito plant (*Pelargonium*) will act against mosquitoes. However, scientists have determined that these plants are “effective” for a limited time only when the leaves are crushed and applied directly to the skin.^[63]

There are several, widespread, unproven theories about mosquito control, such as the assertion that vitamin B, in particular B₁ (thiamine), garlic, ultrasonic devices or incense can be used to repel or control mosquitoes.^{[60][64]} Moreover, manufacturers of "mosquito repelling" ultrasonic devices have been found to be fraudulent,^[65] and their devices were deemed "useless" in tests by the UK Consumer magazine *Which?*,^[66] and according to a review of scientific studies.^[67]

See also

- Fly spray (insecticide)

- Kite Mosquito Patch
- Mosquito net
- Pest control
- RID Insect Repellent
- Slug tape
- VUAA1

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External links

- [1]



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Commons has
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